Location based Solar Tracking Device

Group # SD1208
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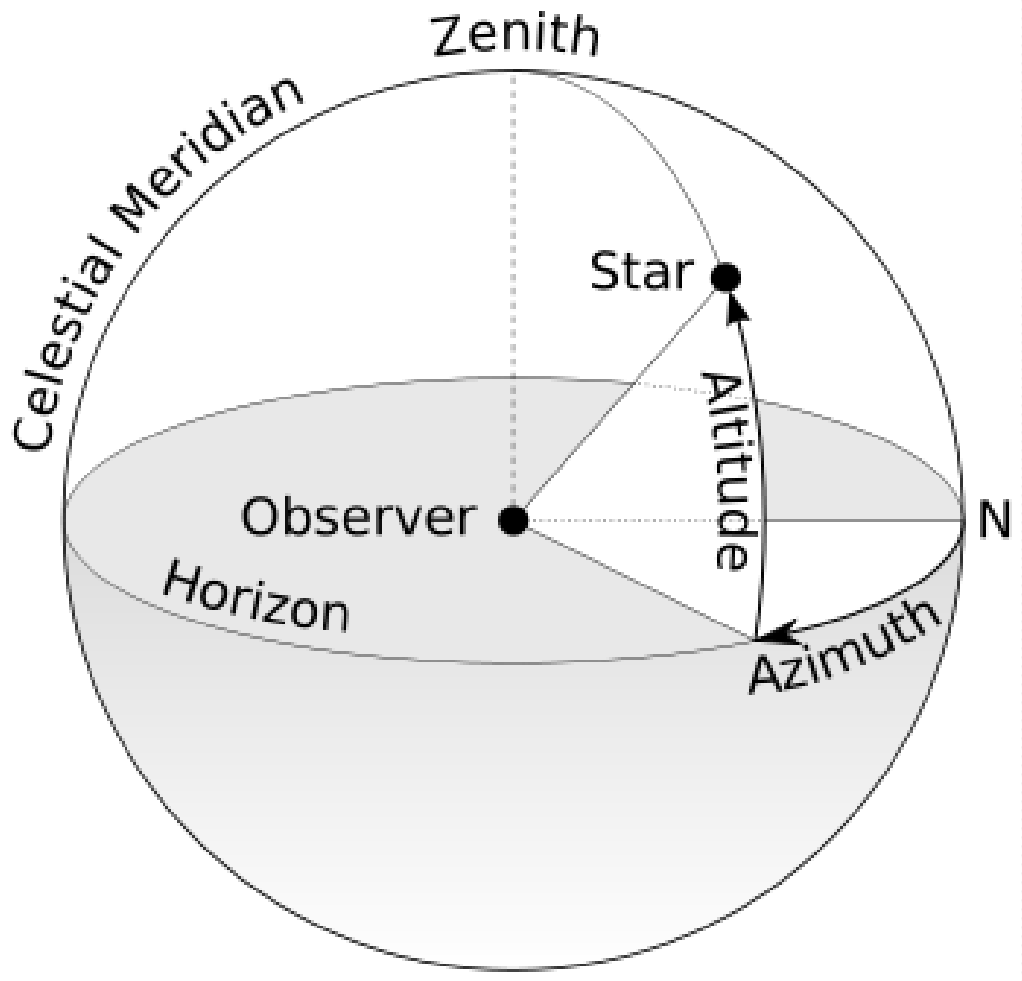
Introduction

John Ihle is our locally based client who wants a location based solar tracker. This involves designing and developing a controller that can be retrofitted to a dual-axis solar photovoltaic tracker system.

Client Requirements

- Currently the system will have to be compatible with both single and dual axis panels
- Current Power that has to be compatible with is a 24V system
- The Panels specifically configured for are Wattsun AZ-225 Azimuth gear drive
- The Panels Have the capability to go 85 degrees to flat and no limit on the horizontal axis rotation
- Automatic and manual modes desired
- The ability to switch between single and dual axis mode also desired
- The desired budget has to be within reason
- Maximum efficiency is desired
- High grade equipment is desired to withstand extreme conditions

How to Determine Solar Position



To determine the solar position of any object in the sky we will need two angles solar azimuth and the solar zenith angles

Device Inputs needed

- Current Calendar Date (GPS)
- Time of Day (GPS)
- The device's longitude and latitude (GPS)
- Panel Face Direction (Digital Compass)

Calculation Variables for Solar Azimuth

- ϕ_s = Solar Azimuth angle
- Θ_s = Solar Elevation angle
- h = Hour Angle at present time
- δ = Sun declination
- Φ = Local Latitude

Solar Azimuth Angle

$$\phi_s = \cos^{-1}\left(\frac{\sin\delta - [\sin\Theta_s]\sin\Phi}{\cos\Theta_s\cos\Phi}\right)$$

$$\delta = \sin^{-1}[.39779\cos(.98565(N+10)) + 1.914\sin(.98565(N-2))]$$

N= Number of days since midnight coordinated Universal Time as Jan 1 begins & can have decimals to adjust for local time zones.

$$\sin\Theta_s = \cos h\cos\Phi\cos\delta + \sin\delta\sin\Phi$$

ϕ_s = Solar Azimuth angle
Θ_s = Solar Elevation angle
h = Hour Angle at present time
δ = Sun declination
Φ = Local Latitude

Solar Zenith Angle

$$\cos \Theta_s = \sin \Phi \sin \delta + \cos \Phi \cos \delta \cos h$$

ϕ_s = Solar Azimuth angle
Θ_s = Solar Elevation angle
h = Hour Angle at present time
δ = Sun declination
Φ = Local Latitude

GPS Sensor

- **RXM-GPS-SR**
- Low power consumption (46mW)
- High sensitivity (159dBm)
- No programming necessary
- Includes Date and Time

Figure 4 shows a typical application for the module.

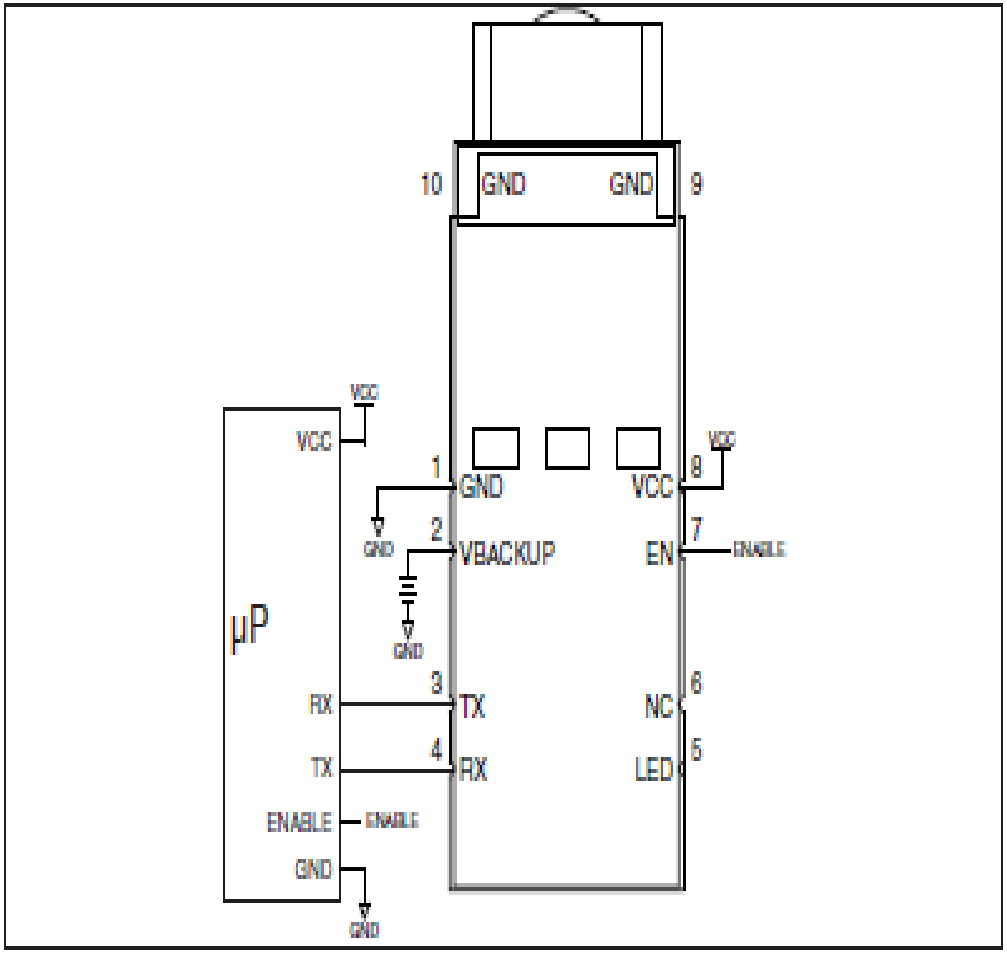
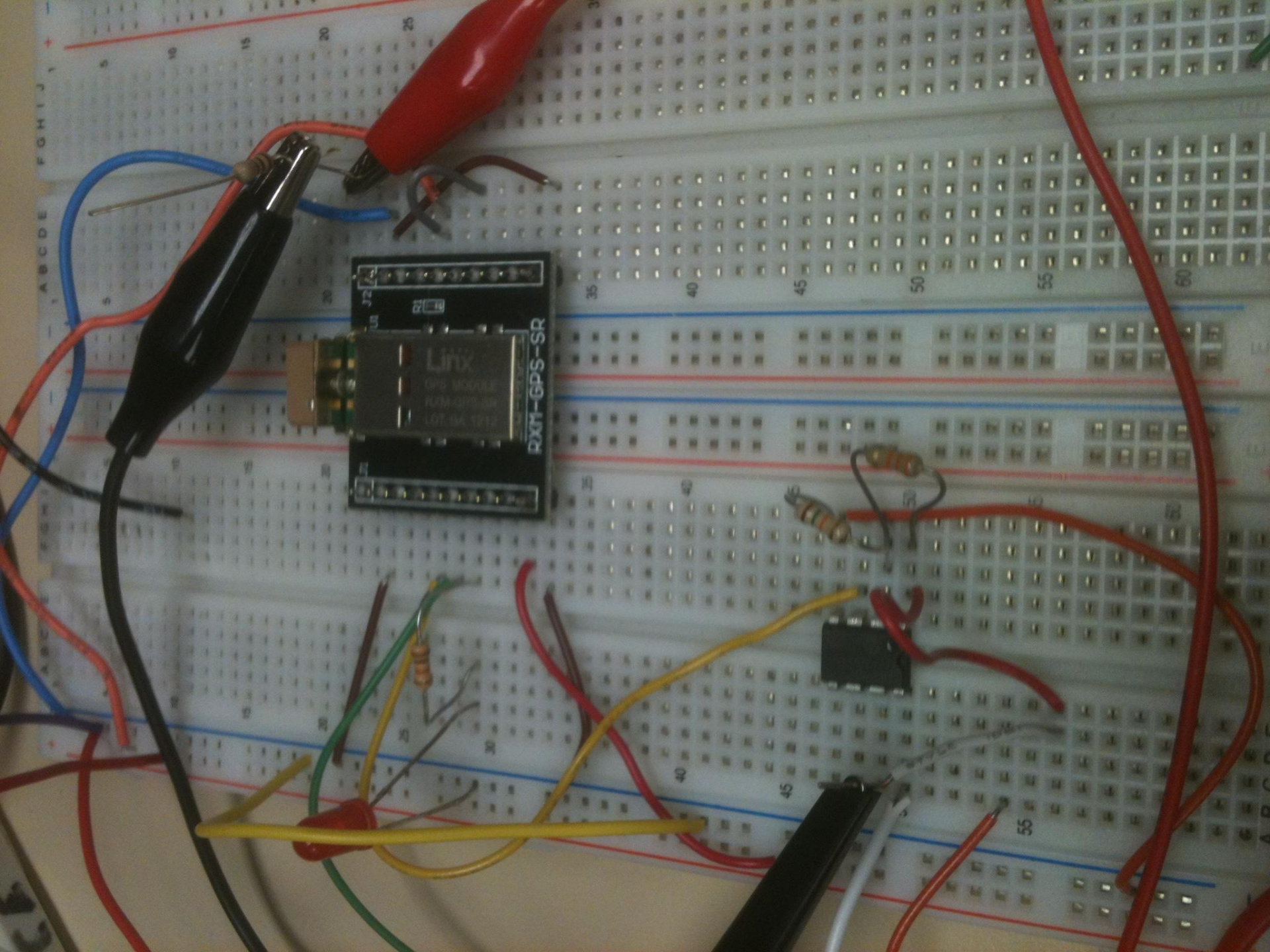
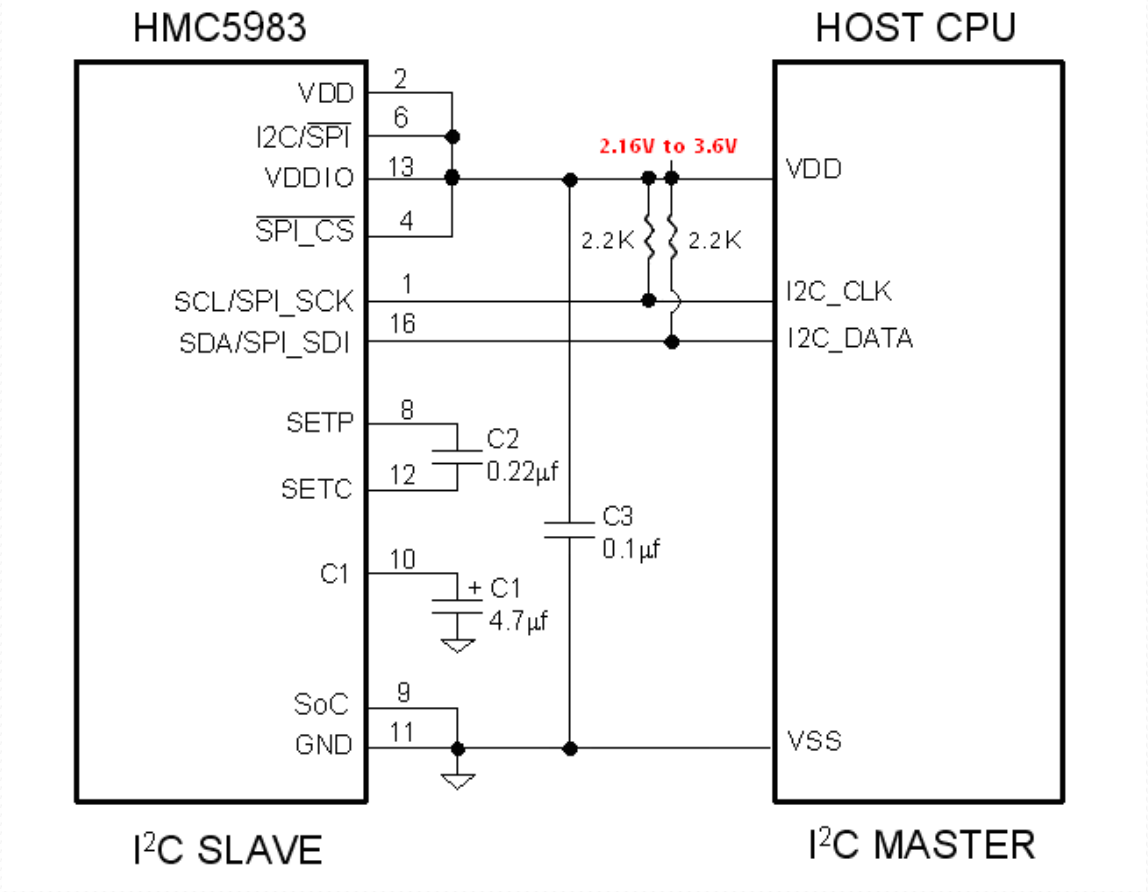


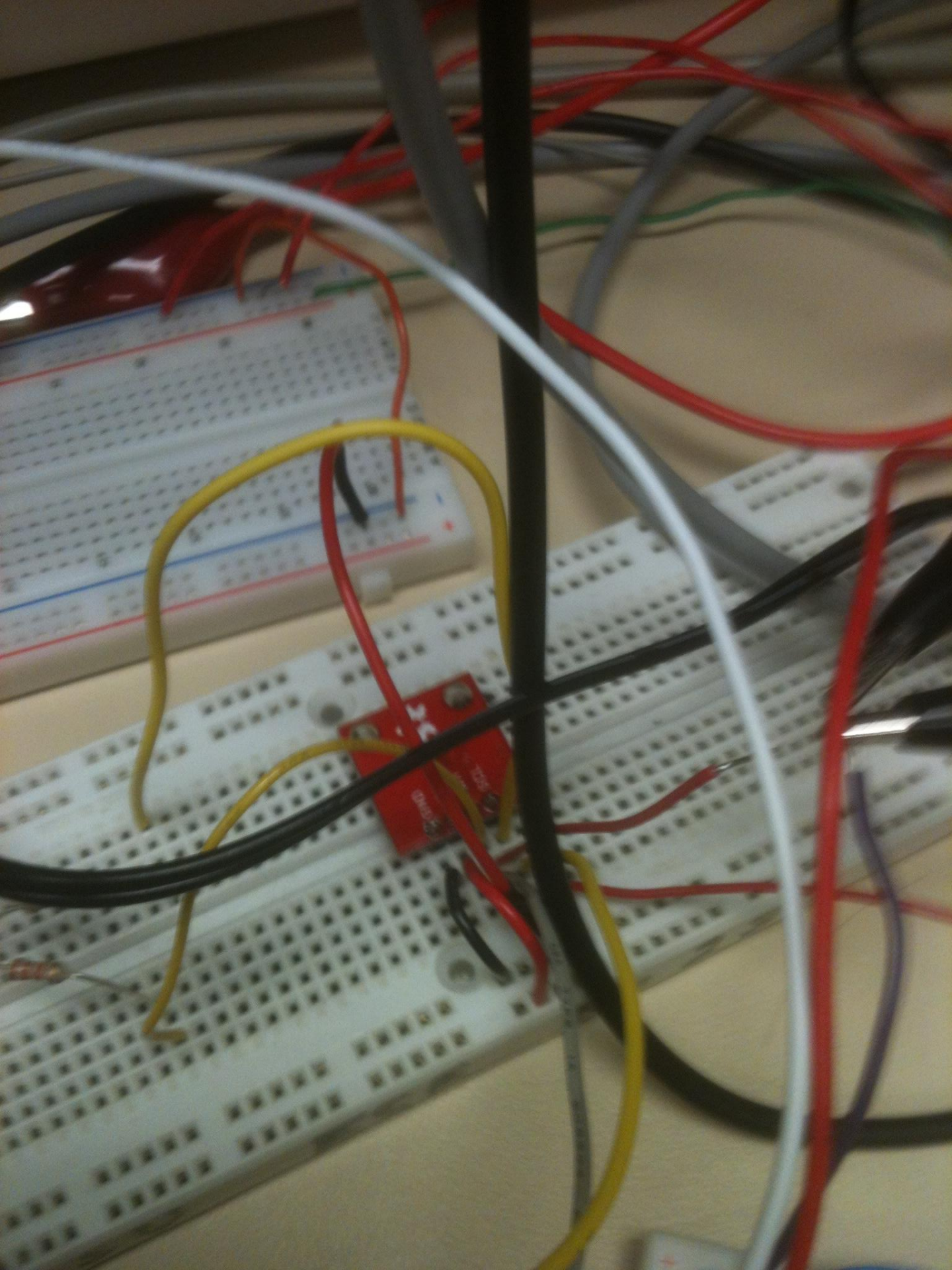
Figure 3: SR Series Module Typical Application


Linx
RXM-GPS-SR

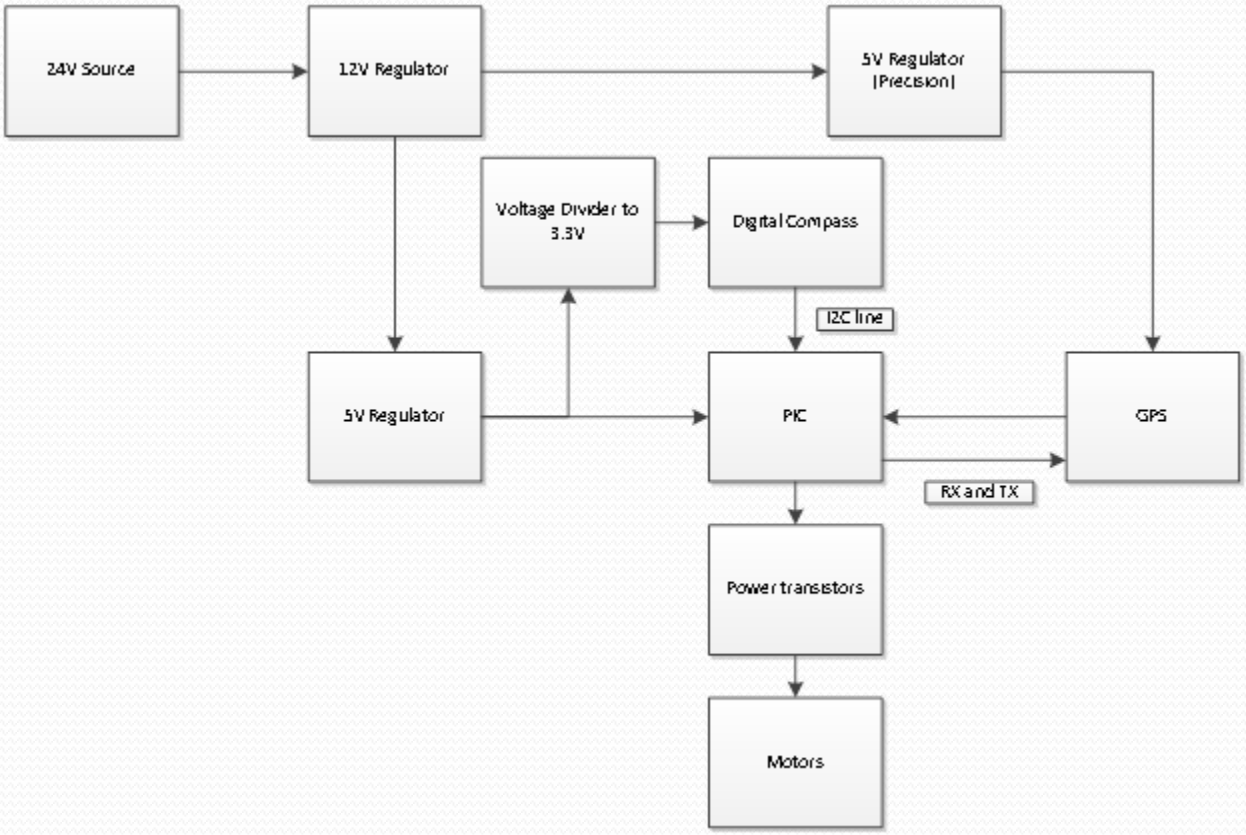
Digital Compass

- Automatically maintains sensor's sensitivity under wide operating temperature range
- High-speed interfaces for fast data communications. I²C up to 3.4 MHz
- Small size for Highly Integrated Products

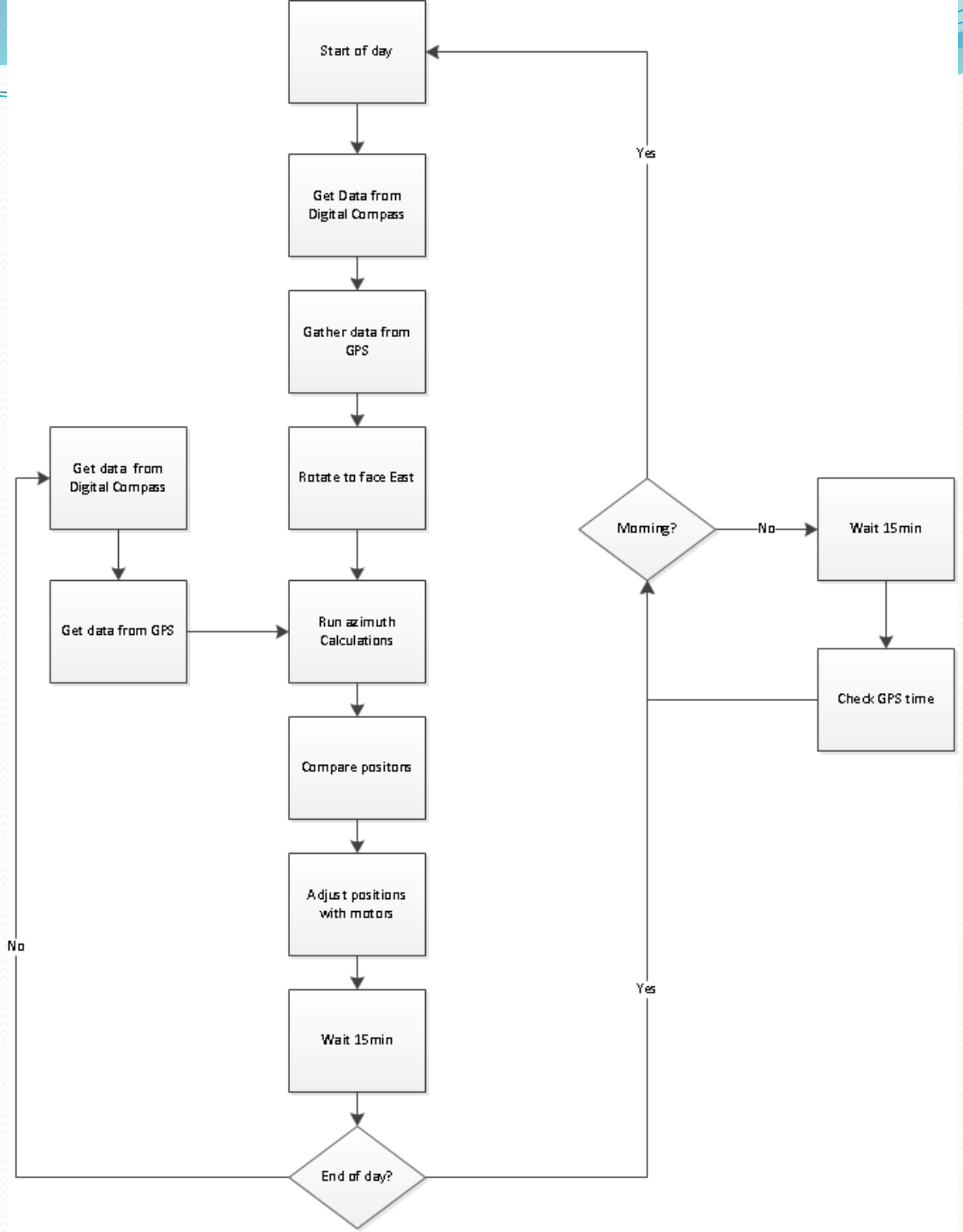


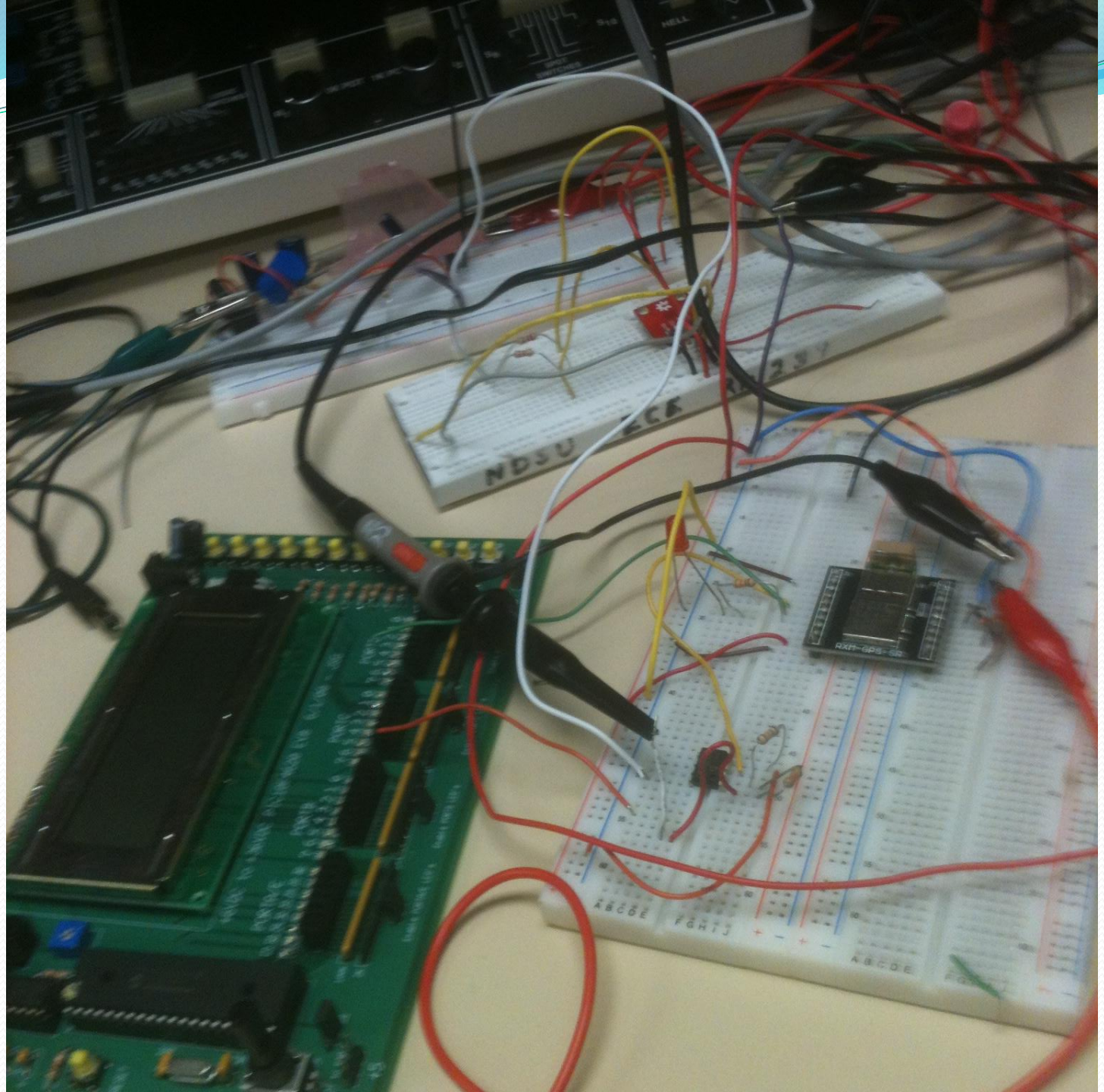


Block Diagram



Flow Chart


Start of day
Get Data from Digital Compass
Gather data from GPS
Rotate to face East
Get data from Digital Compass
Get data from GPS
Run azimuth Calculations
Compare positons
Adjust positions with motors
Wait 15min
End of day?
No
Yes
Morning?
No
Wait 15min
Check GPS time
Yes


NDSU

Current Status

- Essential Hardware ordered
- I^2C (Digital Compass) Code Partially working
- SCI (GPS) Hardware Working, Code In Progress
- Motors Reduced to a Single Motor to Save for Budget
- Current Regulators Working, Possible 3.3V addition in the future

Timeline:

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Requirements Capture meeting					x											
Requirements Capture Document						x										
Options Considered							x									
Order Parts								x								
Make Schematic in Multisim									x							
Program PIC										x	x	x	x	x		
Breadboard PIC (maybe w/o sensors)										x	x	x				
Interface w/ sensors and motor																x
>>> Sensors											x	x	x			
>>> PIC											x	x	x			
>>> Motor																x
Progress Report:													x			
>>> Progress on PIC														x		
Prepare for presentation														x		
Presentations, end of semester															x	

Budget:

Item #	Item Description	Price per Unit	Quanity	Total Cost
1	PIC Microcontroller	$30	2	$60
2	Precision Regulator	$1.50	2	$3
3	Voltage Regulator 12V-5V	$8	4	$32
4	GPS	$50	2	$100
5	Components	$60.00	1	$60
6	PCB	$50	1	$50
7	Digital Compass	$10.00	2	$20
8	Motors	$180	2	$360
9	Power Transistors	$0.75	4	$3
10	Transistors	$0.45	4	$2
			Total	$690

Budget Updated

Item #	Item Description	Price per Unit	Quanity	Total Cost
1	PIC Microcontroller	$30	1	$30
2	Precision Regulator	$1.50	2	$3
3	Precision Regulator	$1.50	1	$2
4	Voltage Regulator 12V-5V	$8	3	$24
5	Voltage Regulator 12V-5V	$8	1	$8
6	GPS	$50	2	$100
7	GPS	$50	1	$50
8	Components	$60.00	1	$60
9	PCB	$50	1	$50
10	Digital Compass	$10.00	2	$20
11	Digital Compass	$10.00	1	$20
12	Motors	$180	1	$180
13	H-Bridge	$8.00	2	$16
			Total Spent	$130
			To Be Spent	$433
			Grand Total	$563

Summary Slide

Our Solar positioning Tracker using a GPS & Digital Compass are Currently in progress. We have had a few hindrances but we are currently making good progress on the project and still are within our goals for the semester.